
Mathematical Modelling in Science and Technology

THE FIFTH INTERNATIONAL CONFERENCE

Berkeley, California, USA July 1985

Edited by

Xavier J.R. Avula

University of Missouri-Rolla

George Leitmann

University of California,
Berkeley

C.D. Mote, Jr.

University of California,
Berkeley

Ervin Y. Rodin

Washington University



PERGAMON JOURNALS LIMITED

A Member of the BPCC PLC Group of Companies



Mathematical Modelling in Science and Technology

THE FIFTH INTERNATIONAL CONFERENCE
ON MATHEMATICAL MODELLING IN SCIENCE AND TECHNOLOGY

Copyright © 1987 Pergamon Journals Limited

All Rights Reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, electrostatic, magnetic tape, mechanical photocopying, recording or otherwise, without permission in writing from the publisher.

First edition 1987



Published as Volume 8 of the journal *Mathematical Modelling* and supplied to subscribers as part of their normal subscription. Also available to non-subscribers.

Printed in Great Britain by A. Wheaton & Co. Ltd, Exeter

CONTENTS

| | |
|--|------|
| Objective, Organizing Committee and Advisory Board | XIII |
| Foreword | XV |

KEYNOTE LECTURES

| | |
|---|----|
| The Evolution and Utilization of Mathematical Models for Drying Carl W. Hall | 1 |
| Second Order Games and Habitual Domain Analysis Po-Lung Yu | 7 |
| Games of Combat M. D. Ardema, M. Heymann, and N. Rajan | 13 |

METHODOLOGY

| | |
|--|----|
| Unified Formulation of Numerical Methods Ismael Herrera | 15 |
| An Overview of the Treatment of Ordinary Differential Equations by Finite Differences Ismael Herrera and Lucia Chargo | 17 |
| A More General Formulation of Separable Least Squares V. G. Dovi, E. P. Arato, and L. Maga | 20 |
| A Bellman's Procedure for a Phase Change Problem L. M. de Socio and G. Gualtieri | 24 |
| Irreducible Invariants of Fourth-Order Tensors Josef Betten | 29 |
| An Incremental Approach for the Solution of Quadratic Programming Problems Kamal Hassan and Faten Mahmoud | 34 |
| Mathematical Modelling of Complex Mechanical Systems Edwin J. Kreuzer | 37 |
| Application of A. I. Techniques to Formulation in Mathematical Modelling Frank Hickman | 43 |
| Models of Flow Networks R. P. Tewarson | 48 |
| Mathematical Modelling of Morphological Analysis Tomasz T. Arciszewski | 52 |
| Modeling and Solving Physical Problems G. Adomian | 57 |
| Time Hierarchy in Systems with General Attractors J. Siska, L. Kubinova, and I. Dvorak | 61 |
| A Two-Dimensional Dispersion Problem-Model Verification and Parameter Estimation K. F. Gerdes and R. L. Bell | 66 |
| A Modification of LJUNG's Theorem with Application to the Analysis of Extended Kalman Filtering L. Gerencser | 72 |
| Computational Method to Compute the Derivative and Antiderivative; with Concern for Terminating a Converging Iterative Process and Considering Accuracy, Roundoff Error, Approximation and Extrapolation William L. Ziegler | 77 |

| | |
|---|----|
| The Use of Information Theory Functionals for Data Smoothing N. S. Tzannes and S. Politaki | 85 |
| On Algebraic Properties of Reliability Vector Measures K. Seitz | 88 |

COMPUTER ARCHITECTURE AND LANGUAGES AND SIMULATION

| | |
|--|-----|
| A Many Sorted Algebra Based Signal Processing Data Flow Language C. R. Giardina | 92 |
| A Mathematical Data/Knowledge Model: The Formal Association Inference Model (FAIM) Doris E. Altenkrüger | 98 |
| Variable Frequency Clock Study Using DSL/VS Martin H. Dost and Chung C. Liu | 102 |
| Kinetic MUSIMPLE - A Computerized, Mathematically Oriented Music Notation System Yael Buksan | 107 |
| Non-Procedural Large-Scale Modelling: Theoretical and Practical Significance Thierry Scheurer | 112 |
| Sequential Estimation of Computer System Availability Trong Wu | 117 |
| An Application of the LEGO Package to PWR Power Plant Modelling Silvano Spelta | 119 |

ANALYTIC HIERARCHY PROCESSES

| | |
|---|-----|
| Decision Making, New Information, Ranking and Structure Thomas L. Saaty | 125 |
| Sensitivity Investigation for a Decision Analysis of the Strategic Defense Initiative (StarWars) Ernest H. Forman | 133 |
| Shortening the Comparison Process in AHP Patrick T. Harker | 139 |
| Modelling a Research Portfolio Using AHP - A Group Decision Process Geoff Lockett, Mike Stratford, Barry Cox, Barrie Hetherington, and Peter Yallup | 142 |
| Venturing into New Technological Markets Ami Arbel | 149 |
| Preference Relations, Transitivity and The Reciprocal Property Luis G. Vargas | 154 |
| Using the Analytic Hierarchy Process to Select Investment in a Heterogeneous Environment Nick Bahmani, David Yamoah, Potkin Basseer, and Farahmand Rezvani | 157 |
| Hierarchical Determination of the Risk of Forced Divestment to Foreign Owned Enterprises in LDC's Glenn E. Hachadorian | 163 |

STATISTICAL AND STOCHASTIC PROCESSES

| | |
|---|-----|
| Non Linear Filtering and Stochastic Textures R. Schott | 167 |
| A Rate Summation Model of Temperature Dependent Development with Stochastic Extensions Jay B. Ghosh | 170 |
| A Method of Matching Data Naphtali Rishe and Michael Hanani | 172 |
| Certain Mathematical, Statistical, Logical, and Philosophical Issues at the Foundations of Mathematical Modelling John Frederick Loase | 175 |

CONTENTS

VII

| | |
|---|-----|
| Toward a Joint Disciplinary Validation of SIGFLUENCE through Mathematical Modeling John Frederick Loose | 180 |
| Statistical Independence - A Misnomer Catherine P. Smith | 183 |
| Programmable Programming Probability Robert K. Krzywiec | 186 |
| Multi...Multi-Structures of Multi...Multi-Information (Ordered, Modeled) Mathematically Robert K. Krzywiec | 190 |
| Calculating Reliability Parameters of Parallely Connected Elements Part I: Two Parallely Connected Elements Sreten Skuletic | 192 |
| Solution of Transient Markovian State Probabilities and Rate of Approach of Equilibrium States K. P. Chung | 198 |

DECISION SCHEDULES

| | |
|--|-----|
| The Role of Processing-by-Attribute Noncompensatory Choice Models Rajshekhar G. Javalgi and Dennis H. Gensch | 203 |
| Modelling Nonlinearities of Multicriteria Locational Decisions Mary W. Cooper | 207 |
| Some Problems in the Analysis of Stochastic Dominance William E. Stein and Roger C. Pfaffenberger | 209 |
| Some Issues in the Mathematical Modelling of Multiple Criteria Decision-Making Problems Vladimir M. Ozerney | 212 |
| Some Asymptotic Results for the Combination of Evidence Problem I. R. Goodman | 216 |
| On Modelling of Expert Knowledge and Admissibility of Uncertainty Measures Hung T. Nguyen | 222 |
| IDES: Influence Diagram Based Expert System Alice M. Agogino and Ashutosh Rege | 227 |
| The Dynamical Behavior of Ensembles of Autonomous Systems as Applied to Large Scale Systems Behaviour of Economic and Societal Systems Myron S. Karasik | 234 |
| An Optimal Physical Database Model Dalia Motzkin | 240 |

PHYSICAL AND CHEMICAL SYSTEMS

| | |
|--|-----|
| The Application of an Implicit Finite Element Algorithm with a Frontal Solution Technique to the Analysis of Time Dependent Viscous Flows Bryan R. Becker and John B. Drake | 245 |
| Robust Modelling of Flow Induced Oscillations of Bluff Bodies W. Herfort and H. Troger | 251 |
| A Mathematical Model for the Three-Dimensional Ocean Sound Propagation Ding Lee and William L. Siegmann | 256 |
| Numerical Treatment of Classical Scattering from Bounded Objects M. F. Werby, G. J. Tango, and K. R. Davey | 257 |
| A First Order Mathematical Model of the Crust of the Earth for Calculating Stresses due to Tangential Forces Giancarlo Spinelli | 262 |
| A Mathematical Model for Gamma Ray Absorption and Scattering I. A. Henderson and J. McGhee | 267 |
| Energy Transfer by Quadratic, Non-Resonant Wave Interactions in a Collisionless Plasma E. D'Ambrogio | 272 |
| Traveling Waves for the Enclosed Atomizer S. L. Paveri-Fontana | 275 |

| | |
|--|-----|
| A Boundary Determined Auger Recombination Model for Semiconductor Power Diodes I. A. Henderson and J. McGhee | 279 |
| Non-Numerical Modeling in Chemistry Carl Trindle | 283 |
| Finite Element Modelling of Galvanic Corrosion During Chemical Cleaning of Westinghouse Series 51 Steam Generator John W. Fu and Siu-Kee Chang | 289 |
| Simulation of Mass Transport in Series Arrays of Membranes with "Active" Solute Flow Fabrizio C. Celentano, Gianluigi Monticelli, and Fabio Cottini | 295 |
| Topological Indices: Their Nature, Mutual Relatedness, and Applications S. G. Basak, V. R. Magnuson, G. J. Niemi, E. R. Regal, and G. D. Veith | 300 |
| The Mechanics of Phase Transformations Elias C. Aifantis | 306 |
| Simulation of Fluid Catalytic Cracking Operation Ihab H. Farag and Kun-Yung Tsai | 311 |
| A Mathematical Model for Obtaining Network Characteristics of Terpolymer Systems N. S. Madhavan and S. Pitchiah | 317 |
| Modelling of the Reversed Compound Pendulum with a Nonperiodically Oscillating Suspension Zdzislaw Denkowski and Janusz Traple | 321 |

ENGINEERING SYSTEMS

| | |
|--|-----|
| Investigation of Constrained-Layer Technique Using Exact Elasticity Theory Pieter S. Dubbelday | 327 |
| Computational Mechanical Analysis of Composite Bondlines Under Environmental Moisture Loads S. McHugh and D. Wadiak | 332 |
| An Experimental-Analytical Hybrid Model for the Elasto-Plastic Stresses at a Crack M. Kondo and G. B. Sinclair | 338 |
| The Use of Integral Methods in Solving Partial Differential Equations-- I. Drying of Very Moist Soil Ronald E. Benson, Jr. and Benjamin L. Sill | 344 |
| The Use of Integral Methods in Solving Partial Differential Equations-- II. Consolidation of Very Soft Soil Ronald E. Benson, Jr. and Benjamin L. Sill | 348 |
| Wind-Excited Vibrations of Transmission Lines: A Comparison of Different Mathematical Models P. Hagedorn | 352 |
| Stochastic Field Processes in the Mathematical Modelling of Damped Transmission Line Vibrations P. Hagedorn, J. Schmidt, and N. Nascimento | 359 |
| Motion of a String Vibrating Against a Rigid Fixed Obstacle Henri Cabannes | 364 |
| Non linear Modelling of the Piston Slap Phenomenon in an Alternative Internal Combustion Engine Antonino Repaci | 366 |
| Fluid Dynamics and Mass Transfer of Interacting Drops - A Mathematical Modelling Approach C. Kleinstreuer and S. Ramachandran | 368 |
| The Relative Importance of the Surface Compressional Modulus of Elasticity and Reynolds Number in Interfacial Turbulence--Mass Transfer Winston Khan | 376 |
| Robot Vibration Modeling and Control Mike Benjamin, Pete Meckl, Alfonso Garcia-Reynoso, and Warren Seering | 383 |
| Model Reference Control and Identification of Robotic Manipulators Under Uncertainty J. M. Skowronski | 384 |

| | |
|--|-----|
| Dynamics of Coal Dust Flame Acceleration: A Feedback Control Model for Unsteady Flow Ernest L. Baker and Walter J. Grantham | 389 |
| Differential Game Control of a Bilinear Solar Collector/Heat Exchanger System Bruce M. Fritchman and Walter J. Grantham | 399 |
| Nonlinear and Bilinear Models for Chemical Reactor Control Eberhard P. Hofer | 406 |
| A Comparative Study of a Heat and Fluid Flow Problem Using Three Models of Different Levels of Sophistication Christine Doughty and Chin-Fu Tsang | 412 |
| A Scavenging Model Analysis Around a Large Coal-Fired Power Plant in New Delhi with a Particular Reference to the Scavenging Action of the Monsoonal Rains S. Ghosh and M. P. Singh | 419 |
| Probabilistic Characterizations of Durability of Reinforced Concrete William S. Perriman | 425 |
| Deterministic Representation of Chaos with Application to Turbulence Michail Zak | 430 |
| A Two-Dimensional Intake Manifold Flow Simulation Peter Li | 437 |
| Realistic Velocity Profiles for Wind-Driven Coastal Currents Myron H. Young and Stephen P. Murray | 443 |
| Species Separation in Narrow Gaps--A Simple Model Amilcare Pozzi and Luciano de Socio | 446 |
| Global Matrix Formulation of Wave Phenomena in Plane Layered Media G. J. Tango, M. F. Werby, and H. Schmidt | 450 |
| A Numerical Solution for the Drawing of a Solid Continuum Through a Stepped Bore Hydrodynamic Unit M. S. J. Hashmi and G. R. Symmons | 457 |
| System Theory as Applied to Machine Tool Stability R. Kadharamanan | 463 |
| Mathematical Modeling of Continuous Dynamic Systems Harold H. Klee | 468 |
| A Computer Simulation of a Rail Network Samuel M. Graff and Peter Shenkin | 472 |
| Mathematical Linkage of Units Commitment and Optimal Dispatch of Large Grid Power System K. Denno | 476 |
| Steady-State and Transient Response Model of Multi-Winding Layers Transformer Due to Lightning Surge K. Denno | 478 |
| The Optimal Fin Profile--A Study in Heuristics and Rigor Arthur David Snider | 480 |
| A Plate Bending Finite Element Model with a Limit Analysis Capacity W. C. McCarthy and L. A. Traina | 486 |
| Computerized R-functions Method and its Application in Linear Elastic Fracture Mechanics J. Orkisz, W. Rachowicz, and M. Wnuk | 493 |
| An Algorithm for Planar Linkage Simulation Andrew D. Dimarogonas | 500 |
| Boundary Integral Methods for Steady-State Optimal Control Problems R. Alsan Meric | 505 |
| Modelling of Car Head-on Collision Based on Stress Waves Concept A. Maslowski, J. Krutul, and T. Surma | 509 |
| A New Model for Nonlinear Subgrades S. Chandra, Madhira R. Madhav, and N. G. R. Iyengar | 513 |
| On Crack Propagation in a Nonlinear Coupled Thermo-Mechanical System C. Ouyang | 519 |

| | |
|--|-----|
| Numerical Analysis of the Oscillating Water Column Wave Energy Extraction System H. C. Alexander, K. C. Watts, and J. W. Graham | 524 |
| Nonlinear Fracture Problems and Finite Elements C. Ouyang | 532 |
| On Path-Independent Integrals γ in Nonlinear 3-Dimensional Fracture Dynamics M. Z. Lu | 536 |
| Numerical Solutions of Unilateral Problems in Elasticity Muhammad Aslam Noor and S. I. A. Tirmizi | 540 |
| Mathematical Modeling and Simulation of Stepping Motor Systems A. Kelemen, M. Crivii, and V. Trifa | 544 |
| Mathematical Modelling and Digital Simulation of a Current-Fed Induction Motor System A. Kelemen and Maria Imecs | 550 |
| A Nonlinear Model for Prediction of Stresses in Submarine Pipelines During Pickup Operations Khyruddin A. Ansari | 556 |
| A Comparative Study of the Effects of Cladding Panel Modelling R. M. Henry and C. Stein | 560 |

BIOLOGY AND BIOMEDICAL SYSTEMS

| | |
|--|-----|
| Triplication vs. Duplication in Regenerated Arthropod Limbs: Multiple Stable States in the Shaping of Cell Sheets Jay E. Mittenenthal | 566 |
| A Rational Approach to the Optimal Design of Drugs M. Randic, B. Jerman-Blazic, S. C. Grossman, and D. H. Rouvray | 571 |
| Optimization of Drugs' Action Using Minimization Methods Y. Cherruault and J. F. Prost | 583 |
| Multilevel Logic as a Tool in Modelling; Application to Glycolytic Reactions Jean Richelle | 588 |
| A Mathematical Model of Antigenic Kinship of Viruses Naphtali Rishe and Michael Lipkind | 592 |
| A Multinephron Model of the Renal Concentrating Mechanism Peter Lory | 597 |
| Pattern Generation and Morphogenesis--A Bifurcation Analysis P. K. Tapaswi and A. K. Saha | 599 |
| A General Method for the Modelling of Complex Physiological Systems G. G. Jaros, P. C. Belonje, and H. Breuer | 604 |
| Evaluation of the Influence of Leaflet Stiffening on Leaflet Stresses of Porcine Bioprosthetic Valves Using a Finite Element Model Hani N. Sabbah, Mohamed S. Hamid, and Paul D. Stein | 609 |
| A Quasilinearization Technique for Analysis of Human Gait Robert S. Roth | 614 |
| A Non-linear Finite Element Model for A Spinal Segment Narayan Yogandan, Joel B. Myklebust, Gautam Ray, Frank Pintar, and Anthony Sances, Jr. | 617 |
| On Representation of Medical Knowledge by a Binary Data Model Naphtali Rishe | 623 |
| A Mathematical Model for the Survival of Cancer Patients Jian C. Chang | 627 |
| A Global Polar Diagram of the Zeroes of the Characteristic Function of an Autoregressive Process to Describe the EEG Sleep Pattern K. Balocchi, A. Macerata, G. Marchesi, A. Biagini, M. Emdin, and L. Donato | 633 |
| Evolution of Proteins: An Ergodic Stationary Markov Chain Georges Cullmann and Jean-Michel Labouygues | 639 |
| The Logic of the Genetic Code Georges Cullmann and Jean-Michel Labouygues | 643 |

CONTENTS

XI

| | |
|--|-----|
| The Use of Compartment Models in Ferrokinetic Analysis E. Venturino, F. Hosain, S. Bozzo, and A. B. Brill | 647 |
| Steady-State Macromolecular Transport Across A Multilayered Arterial Wall Donald L. Fry | 653 |
| Temperature Effect on Collagen-like Structure Leopoldo Millan and Ezio Marchi | 654 |

SOCIO ECONOMIC PROBLEMS

| | |
|--|-----|
| Multilevel Import Demand of ESCAP-Countries Arnold H. Q. M. Merckies and Ivo J. Steyn | 659 |
| Characterization and Uniqueness of Equilibria in Locational Choice Problems E. Ross Barmish and Tamer Basar | 664 |
| Attitude Distribution Change as a Marketing Approach to Action/Sales Maximization Aharon Hibshoosh | 670 |
| The Effect of Public Opinion on Advertising Strategies: The Canadian Cigarette Industry C. Anthony di Benedetto | 674 |
| The Relativistic Balanced Global Energy System Model K. Denno | 679 |
| Generating Production Profiles for an Oil Field Stein W. Wallace, Carsten Helgesen, and Arild N. Nystad | 681 |
| Management of Renewable Resource with a Backstop Substitute Harry R. Clarke and Ram M. Shrestha | 687 |
| Differential Games of Capitalism: A Survey Matti Pohjola | 693 |
| Cyclic and Chaotic Behavior of Intertemporal Optimization Models Michele Boldrin and Luigi Montrucchio | 697 |
| Conflict and Socioeconomic Structure—A Factor Analysis Study Manas Chatterji | 701 |
| Traffic Models for Traffic Control in Urban Areas R. Camus, A. D'Amore, and Walter Ukovich | 706 |
| The Demand for Urban Shopping Travel: A Dynamic Macro Model Norbert Oppenheim | 712 |
| Mathematical Modelling and Economic Evaluation Pablo Serra | 718 |
| Dynamics Modeling of a Disequilibrated System of a Market in the Economy of a Country V. J. Simunek | 723 |
| On ABC Analysis of Multi-Item Inventory Problem T. Odanaka and T. Tanaka | 725 |

MORPHOGENESIS OF PATTERNS ON PLANTS (Special Symposium)

| | |
|---|-----|
| Some Thoughts on Phyllotaxis David A. Young | 729 |
| Association of Coconut Foliar Spirality with Latitude T. Antony Davis and Bernard Davis | 730 |
| Towards a More Universal Model of Phyllotaxis Roger V. Jean | 734 |
| Phyllotaxis as a Dissipative Structure Christopher J. Marzec | 740 |
| Empirical Models of Stem Growth and Vasculature Differentiation Processes Roger D. Meichenheimer | 746 |
| Descriptive Phyllotaxis on Surfaces with Circular Symmetry J. N. Ridley | 751 |

| | |
|---|-----|
| Some Questions of Method in Phyllotaxis Irving Adler | 756 |
|---|-----|

RESOURCE ECOLOGY

| | |
|--|-----|
| Differential Offensive-Defensive Games Between Plants and Herbivores P. L. Antonelli and J. M. Skowronski | 762 |
| Evolution Under Nonequilibrium Dynamics Thomas L. Vincent and Joel S. Brown | 766 |
| Perturbed Higher Order Population Models George Bojadziew | 772 |
| Single Species Migration in Two Habitats: Persistence and Extinction H. I. Freedman | 778 |
| Predator-Mediated Coexistence in a Chemostat: Coexistence and Competition Reversal G. J. Butler and G. S. K. Wolkowicz | 781 |
| Dynamic Systems Modelling and Simulation of Air Polluted Forest Ecosystems Wolfgang Metzler | 786 |
| Ecological Competition Among Three and Four Species Leopoldo Millan, Jose L. Sales, Ricardo H. Velasco, and Ezio Marchi | 792 |
| A New Model of Single Populations with Three Parameters Q. W. Cui and G. Lawson | 797 |
| A Control Theoretic Model of Multispecies Fish Harvesting Kripasindhu Chaudhuri | 803 |
| Author Index | 811 |

